

## EPA/NASA/USAF Depainting Effort Concludes

### Introduction

Marshall Space Flight Center has completed an effort with the Environmental Protection Agency (EPA) and the United States Air Force (USAF) to study environmentally-friendly technologies for removing paint from aircraft. Methylene chloride, a popular paint-stripper, is becoming increasingly regulated in industrial applications due to its possible carcinogenic effects on humans and also its effect on the environment. The EPA regulates the usage of methylene chloride for depainting operations in the National Emission Standards for Hazardous Air Pollutants (NESHAP) for the Aerospace Rework and Manufacturing source category. Additionally, the Occupational Safety and Health Administration (OSHA) has recently imposed strict limits on exposure levels of methylene chloride for workers.

The NASA Operational Environment Team, with its expertise in environmental technologies, coordinated the depainting effort. Marshall's Materials, Processes, and Manufacturing Department was responsible for each step of the processing and evaluations. Representatives from numerous aerospace companies, including Boeing, Lockheed-Martin, Northrup Grumman, Sikorsky, and United Space Boosters, Inc. (USBI), served on a Technical Advisory Committee to ensure that no useful technology was overlooked and the evaluations were fair.

Eight environmentally-friendly methods of stripping paint with products from 34 companies were studied:

- methylene chloride-free chemicals
- carbon dioxide (CO<sub>2</sub>) blasting
- CO<sub>2</sub> laser stripping
- xenon flashlamp and CO<sub>2</sub> coating removal (FLASHJET®)
- high-pressure water blasting (WaterJet)
- wheat starch blasting (EnviroStrip®)
- plastic media blasting
- sodium bicarbonate wet stripping.

Panels cut from aluminum 2024-T3 were tested by all processes. Chemical, plastic media blasting, WaterJet, and sodium bicarbonate stripping methods were evaluated on both clad and non-clad panels. Panels were of 16 mil, 32 mil, 51 mil, and 64 mil nominal thickness. The panels were treated with a chromate conversion coating (Iridite 14-2) then painted with a MIL-P-23377F epoxy primer and MIL-C-83286B polyurethane topcoat, artificially aged through thermal cycling, then stripped. Processing was per draft 4 for ISO/SAE MA4872, "IATA Guidelines for Evaluation of Aircraft Paint Stripping Materials and Processes." The panels were evaluated for any remaining paint or primer and any substrate damage due to the strip method, then refurbished for another cycle of painting, aging, and stripping. Some methods were eliminated after one cycle for poor performance; others were evaluated for as many as five cycles. Following is a brief overview of the various methods.

## **Chemical**

Average dwell times for the non-methylene chloride strippers were much longer than the baselined methylene chloride. Raytheon Aerospace in Selma, AL shared their spray techniques which reduced the average dwell time of more than 7 hours for the first sequence to 5 hours or less for following sequences. Acid strippers appeared to perform slightly better than alkaline or neutral strippers.

## **Carbon dioxide (CO<sub>2</sub>) blasting**

Two different CO<sub>2</sub> blast methods, the Cold Jet® 65-200 and the TOMCO<sub>2</sub> DI-250, were tested. The depainting team determined that these methods were better suited for individual paint layer removal or precision cleaning. The CO<sub>2</sub> blast methods were not suitable for thin substrates such as the 16-mil thick aluminum.

## **CO<sub>2</sub> laser stripping**

Silicon Alps of Santa Clara performed the CO<sub>2</sub> laser stripping for this study, successfully removing both topcoat and primer. The 2 kilowatt production laser performed much better than the 50 watt laboratory demonstration laser and had strip rates comparable to other mechanical strip methods.

## **FLASHJET®**

The FLASHJET® process combines a xenon flashlamp with a low-pressure CO<sub>2</sub> particle stream to remove coatings. This combination performed better than CO<sub>2</sub> blast alone and worked best when tailored to leave approximately 0.5 mil of primer remaining on the substrate. Some customers prefer this since a new topcoat can be applied without re-applying the Iridite and epoxy primer. During the first sequence, removal of all of the topcoat and primer sometimes resulted in damage to the substrate. With each successive stripping sequence, the FLASHJET® process was better adapted to this study, eliminating further substrate damage. The thickness, reflectivity and emissivity of the paint system all affect the strip rate and effectiveness of the FLASHJET® process.

## **WaterJet**

The high pressure water jets in this process were effective at removing paint. Water pressure should be limited to 20 ksi for thin panels, as the 16-mil panels showed dimpling with water pressures at 22 ksi. Thicker panels, such as 51-mil and 64-mil, were adequately stripped with water at 30 ksi. Multiple passes at lower water pressures were more effective than trying to strip in one pass with higher water pressure.

## **EnviroStrip®**

Pure wheat starch is processed into a crystalline form to a desired hardness. The blast media can be recycled as long as a dense particle separator is used to remove any contaminants such as sand or metal particles. The blast media is effective for approximately 20 strip sequences before it must be replaced. Like the FLASHJET® process, the EnviroStrip® process can be tailored to remove only the topcoat.

**Plastic media blast**

Four strip cycles allowed the process engineer to tailor the size of the plastic media, flow rate, pressure and stand-off distance for optimum stripping. Topcoat and primer were adequately removed by the plastic media, but it was noted that the media stripping effectiveness dropped off after 10 uses. While panels for this test series were manually stripped, this process is suitable for automation.

**Sodium bicarbonate**

Sodium bicarbonate wet stripping proved too aggressive for the 16-mil thick panels but was effective at removing paint from the 32-mil, 51-mil, and 64-mil substrates. The operator experienced some problems with nozzle clogging. Lessons learned in the water jet stripping process were also applicable to the sodium bicarbonate process since high pressure water is used.

**Conclusions**

The final report contains strip rate data from all of the methods, lessons learned during processing, metallurgical evaluations of the panels, and summaries of corrosion and hydrogen embrittlement studies. Any changes in surface roughness, fatigue and tensile properties, and crack detectability are noted in the report. No process was singled out above the others, as companies should consider equipment and operational costs when complying with the Aerospace NESHAP and new OSHA regulations.

Copies of the depainting final report are available from  
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